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DUCK-PROCESSING WASTE

U. S. DEPARTMENT OF HEALTH,
EDUCATION, AND WELFARE
Public Health Service

DUCK-PROCESSING WASTE

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
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CONTENTS

	Page
ABSTRACT	v
INTRODUCTION	1
SURVEY PROCEDURES	1
DESCRIPTION OF PLANTS	2
PRESENTATION OF DATA	3
DISCUSSION	8
ACKNOWLEDGMENT	11
REFERENCES	13

ABSTRACT

Two duck-processing plants located on Long Island were studied to obtain waste load and water use data for comparison with chicken processing data.

Weighted averages for both plants studied indicate water use of 23.6 gallons and waste loads of 0.0419 pound BOD and 0.0289 pound of suspended solids per duck processed. Similar values for chicken processing are 8 gallons of water, 0.025 pound of BOD, and 0.013 pound of suspended solids per bird.

Comparisons between duck and chicken processing on the basis of 1,000 pounds of live birds indicate water usage is 3,600 gallons for ducks and 2,300 gallons for chickens; BOD values are 6.4 pounds for ducks and 7.18 pounds for chickens; and suspended solids values are 28.9 pounds for ducks and 13 pounds for chickens. Waste water coliform values were 56,800 per 100 milliliter in plant A and 49,200 per 100 milliliter in plant B.

DUCK-PROCESSING WASTE

INTRODUCTION

The center of duck production activity has historically been located on Long Island where the sandy shores, salt-water coves, and estuaries together with a supply of uncontaminated ground water have, in the past, been abundantly available. Long Island produces 60 to 70 percent of the total ducks processed for market under Federal inspection. [1]

In recent years and particularly since World War II, the influx of people to Long Island has rapidly increased. The development of new areas and the expansion of established areas for houses, businesses, industry, recreational and resort activities, and governmental installations have resulted in increased pressure for water pollution control and in competition for available fresh water. The duck industry is also competing for unpolluted water supply and recognizes the increasing importance of water conservation to delay the possible depletion of existing supplies or contamination of these supplies by intrusion of salt water or other materials.

Much has been written about the pollution control problems of duck farms, [2, 3, 4] but little information is available pertaining to water use and waste loads associated with duck-processing plants.

Recognizing this need for information, the Agricultural Marketing Service, Poultry Division, U.S. Department of Agriculture, and the Public Health Service, Water Supply and Pollution Control Division, have cooperated in field studies to secure data from two Long Island processing plants for evaluation. These studies form the basis for this report.

Objectives of the study were (1) to measure and evaluate duck-processing plant waste loads and (2) to observe plant operations for possible reduction in total water use by redistribution or by reuse of certain waters presently discharged to waste after one use, or by a combination of redistribution and reuse.

SURVEY PROCEDURES

Two processing plants, designated A and B, were studied.

Weirs and water-level recorders were installed on plant-waste discharge lines for measurement of flow on the days when chemical and bacteriological samples were collected.

The chemical samples were collected at 30-minute intervals during the processing and cleanup periods in the plant. Incremental samples were composited to provide one daily sample from each waste source. Bacteriological samples were collected twice each day, at midmorning and midafternoon.

Composite samples were examined in the laboratory for biochemical oxygen demand (BOD), suspended solids (SS), volatile suspended solids (VSS), grease, hydrogen ion concentration (pH), ammonia nitrogen, organic nitrogen, total phosphate, and total coliform by the membrane filter technique (MF). The analyses were performed in accordance with Standard Methods for the Examination of Water and Waste Water, 11th edition, 1960.

Analytical work was performed by PHS personnel at the Duck Research Laboratory, Eastport, L.I. Supporting field personnel were furnished by both the Agricultural Marketing Service and Public Health Service.

DESCRIPTION OF PLANTS

Plant A

Plant A is a two-line plant designed for processing 1,200 ducks per line per hour.

Ducks are hauled from the farms each morning in semitrailers equipped with two decks and compartmented by use of adjustable and removable partitions located on each deck. At the plant, ducks are unloaded into holding pens, according to ownership, from which they are herded into a runway and hung on traveling shackles. They then proceed through the plant operations in the following order: kill and bleed, electric eye count, scald, defeather, first hot-wax dip, chill, remove wax, second hot-wax dip, chill, remove wax, pin, eviscerate, chill, grade, wrap, weigh, package, freeze, and store. All product processing at this plant is Federally inspected.

Liquid blood from the bleed room floor flows into a pit from where it is pumped into a Dempster-Dumpster container outside the building. This blood is hauled to the local dump for disposal. Congealed blood remaining on the floor at the end of the day is flushed into waste line No. 1.

Feathers are recovered from the dressing area flow-away system by rotary screens and returned to the duck raiser, feet are packaged for shipment to Hong Kong. Heads, trimmings, and viscera are removed from the evisceration flow-away system by rotary screens, passed through a grinder, and then packaged, frozen, and shipped to mink farms.

Process liquid wastes are discharged to a settling pond, thence to a second pond. The effluent from pond No. 2 is discharged to an arm of Moriches Bay. Cooling water from refrigeration equipment is discharged to pond No. 2. Sanitary wastes are discharged to a septic tank and absorption field.

Plant B

Plant B is a single-line operation with a variable production capacity depending upon the number of employees, the operating time, and the section of plant utilized. There are two separate plants on this farm both under Federal supervision: a New York Dressed Kosher operation and a dressing and eviscerating unit. The dressing and eviscerating unit was used for this study.

This privately owned plant processes ducks raised by the owners. The ducks are trucked to the plant, unloaded into holding pens, and then herded into a runway and hung on traveling shackles. The processing procedure is as follows: kill and bleed, scald, defeather, first hot-wax dip, chill, remove wax, second hot-wax dip, chill, remove wax, pin, eviscerate, cleanup, chill, grade, wrap, weigh, package, freeze, store, and ship.

All liquid wastes, except blood, are collected in a single outfall line and discharged to ponds. Feathers, feet, viscera, blood, and other parts are handled similarly to the same materials in plant A.

PRESENTATION OF DATA

Plant A

The waste flows from plant A are separated into four categories, since the piping arrangement in the plant provides for four separate discharge lines.

Waste line 1 collects wastes from the dressing operation, including holding, killing, scalding, defeathering, waxing, pinning, grading, packaging, refrigerating, and storing. Waste line 1 discharges into pond No. 1.

Waste line 2 collects wastes from the evisceration operation, including the head, neck, feet, viscera, and wastes from cleanup and the chill tanks. This waste line discharges to pond No. 1 below the water surface.

Waste line 3 collects the sanitary wastes from the plant and office toilets, lavatories, drinking fountains, showers, etc. Waste line 3 discharges to a septic tank and absorption field on the plant grounds. The flow and strength of this waste were not measured.

Waste line 4 collects cooling water from the refrigeration compressors and condensors. Waste line 4 discharges without further use to pond No. 2. The volume of this waste water was not measured, but was estimated.

The total water supply from the two plant wells was metered. Data on water supply and waste discharge volumes are presented in Table 1.

Line 2 discharges below the surface of pond No. 1, which makes a direct measurement of flow difficult. Consequently, the outflow from pond No. 1 was measured and the flow from line 2 was computed by difference with an allowance made for pond seepage. Samples from line 2 were withdrawn from the evisceration waste rotary screen pit inside the plant building. Samples from line 1 were collected at the point of discharge to pond No. 1.

In manipulation of the raw data to compute pounds of waste and unit values of production, only the waste volume from waste line 1 (dressing operation) and waste line 2 (evisceration operation) were used. The sanitary and cooling water wastes were disregarded since they were not mixed with the other plant wastes and were not sampled.

Table 1. PLANT A, WATER SUPPLY AND WASTE FLOW

Date, March 1964	Water supply, metered, gpd	Waste line 1, measured, gpd	Waste line 2, computed, gpd	Waste line 3,[a] estimated, gpd	Waste line 4,[a] estimated, gpd
16	491.700	162,700	236,300	42,300	50,400
18	402,900	124,600	180,700	47,200	50,400
19	403,500	129,200	176,900	47,000	50,400
23	406,100	144,000	176,000	35,700	50,400
Total	1,704,200	560,500	769,900	172,200	201,600

[a]Not included in calculations for waste strength and unit values.

The BOD and chemical analyses of composite samples from waste lines 1 and 2 are shown in Table 2. Of interest are the lower values of pH, BOD, SS, and phosphate concentrations in the waste from evisceration as compared with those from the waste from dressing. The pH value is significantly raised in the dressing waste because of the alkaline blood present and the smaller quantity of water used. The well-water supply has a pH of 6.2 from well No. 1 and 6.4 from well No. 2.

The average BOD concentration for the 4 days is less in the evisceration waste water owing to the greater volume of water used in the evisceration process. The total pounds of BOD in each waste are, however, comparable since waste line 1 contained 55 percent, and waste line 2, 45 percent of the total. Total pounds of SS were similarly distributed, with 57 percent in waste line 1 and 43 percent in waste line 2; the pounds of total phosphate were distributed 67 percent and 33 percent in waste lines 1 and 2, respectively.

The amount of grease was considerably greater in the evisceration waste, as would be expected. Total coiform (MF) was significantly less in the evisceration waste than in the dressing waste. The weighted average of total coliform for all processing wastes was 56,800 per 100 milliliters, as indicated in Table 3.

Unit value relationships of waste discharged versus product produced, as presented in Table 3, are computed from measured values of waste flow, concentration of pollutants present, and the number of ducks processed.

Average volume of waste per duck processed at Plant A was 24.3 gallons. This is three times the average of 8 gallons per chicken as reported by Porges and Struzeski.[5] Comparison of flow on the basis of the average live weight of ducks and chickens indicates 3.6 gallons per pound of duck and 2.3 gallons per pound of chicken. The duck waste flow on this equivalent weight basis is only one-and-one-half times greater than the chicken waste flow.

Table 2. PLANT A. LABORATORY AND PHYSICAL DATA

Date	3-16-64		3-18-64		3-19-64		3-23-64	
Waste line	1	2	1	2	1	2	1	2
Ducks processed, No.	16, 225		12, 370		12, 026		14, 070	
Evisc wt, total lb	81, 419		52, 494		56, 655		64, 254	
Waste water flow, gpd	162, 700	236, 300	124, 600	180, 700	129, 200	176, 900	144, 000	176, 600
pH	7.0	6.6	7.1	6.5	7.4	6.4	6.7	6.7
BOD, mg/liter	278	160	276	136	241	175	317	189
SS, mg/liter	217	97	232	130	177	121	203	108
VSS, mg/liter	206	96	188	113	161	115	191	107
Grease, mg/liter	31	78	105	132	28	109	51	178
NH_4-N, mg/liter	0.65	0.05	1.27	0.07	0.51	0.05	0.78	0.05
Org-N, mg/liter	43	14	41	13	42	12	44	13
Total PO_4, mg/liter	90	35	136	32	191	49	93	31
Coliform (MF), No./100 ml	140, 000	7, 600	48, 000	7, 400	56, 000	7, 400	150, 000	14, 000

Table 3. PLANT A, UNIT VALUES: WASTE VS PRODUCT

Date	3-16-64			3-18-64			3-19-64			3-23-64			Weighted average
Waste line	1	2	Total	1	2	Total	1	2	Total	1	2	Total	
Ducks processed, No.			16,225			12,370			12,026			14,070	
Daily waste flow, gal[a]	162,700	236,300		124,600	180,700		129,200	176,900		144,000	176,600		
Gal waste/duck processed	10.0	14.6	24.6	10.0	14.6	24.6	10.7	14.7	25.4	10.2	12.6	22.8	24.3
Live wt, lb[b]			116,500			75,000			81,000			91,800	
Avg live wt, lb			7.17			6.06			6.73			6.53	6.66
Gal/1,000 lb live wt	1,395	2,035	3,430	1,660	2,400	4,060	1,595	2,185	3,780	1,570	1,920	3,490	3,650
Evis wt, lb[c]			81,419			52,494			56,655			64,254	
Avg evis wt, lb			5.02			4.24			4.17			4.57	4.66
Gal/1,000 lb evis wt	2,000	2,910	4,910	2,375	3,440	5,815	2,280	3,120	5,400	2,240	2,750	4,900	5,220
BOD, lb	377	316	693	287	205	492	260	258	518	382	278	660	
BOD, lb/1,000 live duck			42.7			39.8			43.0			46.9	43.2
BOD, lb/1,000 lb live wt			5.94			6.56			6.39			7.18	6.49
BOD, lb/1,000 lb evis wt			8.52			9.37			9.15			10.28	9.27
Live ducks, No./PE[d]			3.91			4.53			3.89			3.57	3.87
SS, lb	294	192	486	241	196	437	191	179	370	245	159	404	
SS, lb/1,000 live duck			30.0			35.4			30.7			28.7	31.0
SS, lb/1,000 lb live wt			4.17			5.83			4.57			4.41	4.66
SS, lb/1,000 lb evis wt			5.97			8.32			6.53			6.29	6.65
Coliform, No./100 ml													56,800

[a]Excludes cooling water for refrigeration and water for employee sanitation.
[b]Live weight computed; multiply eviscerated weight by factor 1.43.
[c]Eviscerated weight is scale weight.
[d]Population Equivalent (PE) is based on 0.167 pound of BOD per person.

In the waste flow-away systems of plant A, the BOD was 43 pounds per 1,000 ducks. Similarly, for chicken waste the BOD was 25 pounds per 1,000 chickens.[4] When these values are compared on the basis of average live weight, we obtain values of 6.5 pounds BOD per 1,000 pounds duck and 7.1 pounds BOD per 1,000 pounds chicken. The SS values are 4.7 pounds per 1,000 pounds duck and 3.7 pounds per 1,000 pounds chicken.

Plant B

All the flow-away wastes except blood from processing plant B are screened, collected into a single sewer, and then discharged into open ponds excavated in sandy soil. These ponds have no surface discharge since the waste seeps into the underground sands. One pond is used until the seepage rate decreases to less than the total daily addition of waste, whereupon another pond is used and the first one is allowed to dry. The accumulated solids are removed from the walls and bottom of the dry pond and buried at another location. Exposure of the fresh sand prepares the dry pond for additional service.

The water supply to plant B is furnished from wells, but these were not equipped with meters for measuring the quantity used. The waste flow was diverted over a V-notch weir with continuous measurement of the head by a water-level recorder. Waste flow values are not given at the request of the plant owner.

Laboratory data are shown in Table 4. The BOD concentration is within the range of ordinary domestic sewage whereas SS, ammonia, and coliform are less and the grease and total phosphate concentrations are larger.

Table 4. PLANT B, LABORATORY AND PHYSICAL DATA

Date	3-19-64	3-20-64	3-25-64
Evis wt, total lb	17,506	16,207	12,114
pH	7.2	7.0	7.2
BOD, mg/liter	172	209	261
SS, mg/liter	130	94	105
VSS, mg/liter	123	79	99
Grease, mg/liter	111	67	98
NH_4-N, mg/liter	0.36	0.84	0.35
Org-N, mg/liter	16.8	28.1	31.0
Total PO_4, mg/liter	79	57	83
Coliform, No./100 ml	16,000	78,000	51,000

Unit values for several relationships between production and waste loads are shown in Table 5. Waste flow varied from 17.7 to 23.4 gallons per duck processed and from 4,170 to 5,380 gallons per 1,000 pounds ready-to-cook duck.

Table 5. PLANT B, UNIT VALUES: WASTE VS PRODUCTS

Date	3-19-64	3-20-64	3-25-64	Total	Weighted average
Gal waste/duck processed	19.4	23.4	17.7		20.1
Avg live wt, lb	6.67	6.70	4.69		6.00
Gal/1,000 lb live wt	2,910	3,500	3,760		3,350
Avg evis wt, lb	4.67	4.68	3.28		4.21
Gal/1,000 lb evis wt	4,170	5,010	5,380		4,780
BOD, lb	105	141	142	388	
BOD, lb/1,000 live duck	28	41	38		35.6
BOD, lb/1,000 lb live wt	4.19	6.07	8.21		5.92
BOD, lb/1,000 lb evis wt	5.98	8.70	11.70		8.46
Live ducks, No./PE[a]	5.96	4.07	4.39		4.64
SS, lb	79	64	57	200	
SS, lb/1,000 live duck	21.1	18.5	15.5		18.3
SS, lb/1,000 lb live wt	3.16	2.76	3.29		3.05
SS, lb/1,000 lb evis wt	4.51	3.95	4.71		4.37
Coliform, No./100 ml					49,200

[a]Population Equivalent (PE) is based on 0.167 pound of BOD per person.

The BOD and SS varied from 28 to 41 pounds and 15 to 21 pounds, respectively, per 1,000 live ducks. Total coliform varied in concentration from 16,000 to 78,000 per 100 milliliters, with a weighted average of 49,200 per 100 milliliters for the 3 days when samples were collected.

DISCUSSION

Study of two duck-processing plants located on Long Island provides data pertaining to water use, waste loads, and general operation. The finished product is a high-quality duck of considerable delicacy.

The relatively short processing time of approximately 1-1/4 hours between kill and quick freeze operations, the abundant use of water for cleaning and chilling, coupled with careful inspection and grading, contribute to maintenance of a very high-quality product.

Relatively low coliform counts in the flow-away water from the evisceration process indicate careful operation in the removal of viscera, with infrequent rupture of the intestines and possible contamination of the carcass. Fortunately at plant A it was possible to determine coliform concentrations separately for evisceration and dressing operations. Measured values in the evisceration waste varied from 7,400 to 14,000 coliform per 100 milliliters with a weighted average of 9,000 per 100 milliliters. Total coliform concentrations found in composite duck-processing waste varied from 16,000 to 150,000 per 100 milliliters with a weighted average (both plants) of 55,700 per 100 milliliters.

Water usage in duck-processing plants seems rather high when one compares the waste volume from duck processing with the waste volume in chicken processing. In Table 6 the overall average waste volume for both duck plants was 23.6 gallons per duck as compared

with 8 gallons per chicken processed. When water uses based on waste volumes are compared on the basis of live weight, we have 3,600 gallons per 1,000 pounds live duck and 2,300 gallons per 1,000 pounds live chicken or 57 percent greater usage for ducks. The eviscerated weight figures are 5,150 gallons of waste per 1,000 pounds duck and 2,890 gallons per 1,000 pounds chicken or 78 percent greater water usage in duck processing.

Table 6. SUMMARY DATA: DUCK AND CHICKEN PROCESSING

	Duck plant A	Duck plant B	Total-avg[a] both duck plants	Chicken processing
Waste flow, total gal	1,330,400			8,000[b]
Birds processed, total No.	54,691			1,000
Gal waste/bird processed	24.3	20.1	23.6	8
Live wt, total, lb	364,300			3,480
Avg live wt, lb	6.66	6.00	6.55	3.48[b]
Gal/1,000 lb live wt	3,650	3,350	3,600	2,300
Evis wt, total lb	254,822			2,765[c]
Avg evis wt, lb	4.66	4.21	4.58	2.76
Gal/1,000 lb evis wt	5,220	4,780	5,150	2,890
BOD, mg/liter	213	212	213	374
BOD, lb, total	2,363	388	2,751	25
BOD, lb/1,000 live birds	43.2	35.6	41.9	25[b]
BOD, lb/1,000 lb live birds	6.49	5.92	6.40	7.18
BOD, lb/1,000 lb evis bird	9.27	8.46	9.15	9.04
Live birds, No./PE[d]	3.87	4.64	3.99	6.68
SS, mg/liter	155	110	147	195
SS, lb, total	1,697	200	1,897	13
SS, lb/1,000 live birds	31.0	18.3	28.9	13[b]
SS, lb/1,000 lb live birds	4.66	3.05	4.41	3.73
SS, lb/1,000 lb evis bird	6.65	4.37	6.31	4.70
Total coliform, No./100 ml	56,800	49,200	55,700	

[a]Weighted averages.
[b]Reference No. 6.
[c]Eviscerated weight of chickens, 74 percent of live weight.
[d]Population Equivalent (PE) is based on 0.167 pound of BOD per person.

Reduction in total water used in duck processing could probably be achieved without lowering product quality by adoption of some of the conservation concepts listed below:

1. The clean water from refrigeration compressors and condensors could be used for boiler make-up water, holding pen cleaning, scald vat, dressing room cleanup, and feather flow-away and evisceration flow-away systems.

2. The chill water used following evisceration could be reused for hardening wax in pinning operations, for scald tank, flow-away flumes in dressing and evisceration operations, and floor washing in holding pens, bleed room, and picking areas. Fine screening of the chill water may be necessary for some of these reuses.

3. The entire water system should be designed and operated to provide the proper quantity of water at the proper pressure to perform the task required at the various stations on the processing line. This concept could be realized by evaluation of the number, size, and shape of nozzles needed and by control of nozzle pressure by use of pressure-reducing valves. Since the quantity of water discharged through a given orifice is related to the pressure, an incremental saving in water per outlet would add up to a large volume when the great number of nozzles used in the plant is considered.

Table 6 provides other comparisons between wastes from duck processing and chicken processing. The BOD concentrations vary widely, but when these are reduced to pounds of BOD per unit of production the difference is less significant. For example, the pounds of BOD per 1,000 pounds of eviscerated bird is 9.15 pounds for ducks and 9.04 pounds for chickens. The pounds of BOD per 1,000 pounds of live bird were 6.40 pounds BOD for ducks and 7.18 pounds for chickens.

From these data it is possible to establish comparable unit waste values between the processing of ducks and other poultry by making such comparisons on the basis of unit weight.

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